COMET-VR:
A carbon sequestration decision support tool

Richard T. Conant, Keith Paustian, John Brenner, Roel Vining, Stephen Ogle, Ken Killian, Mark Easter, Steve Williams

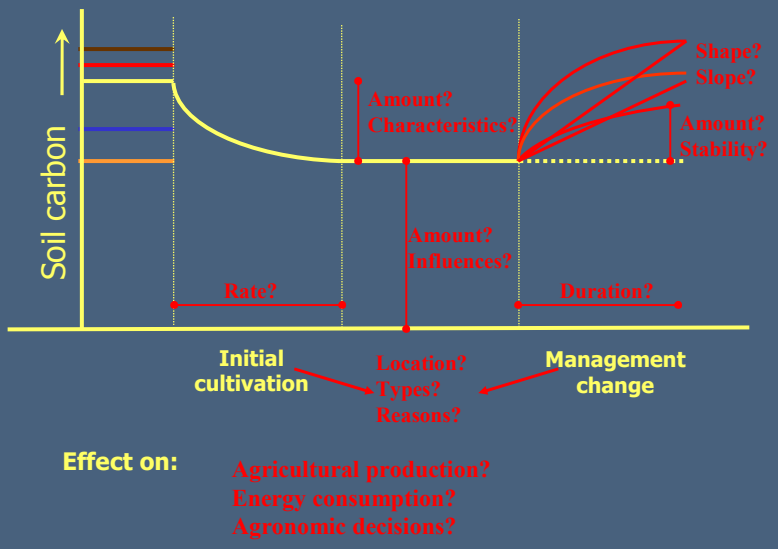
and others too!

Colorado State University®

What are the challenges ?

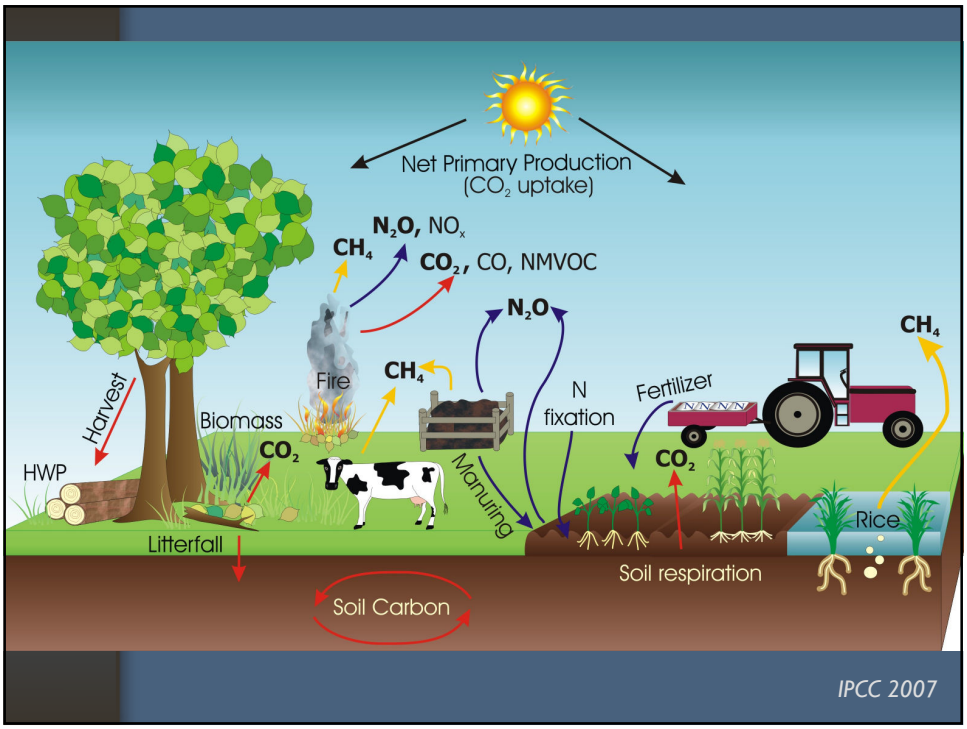
- Soil C stocks and changes in stocks are contingent on several variables

Soil C trajectories



What are the challenges ?

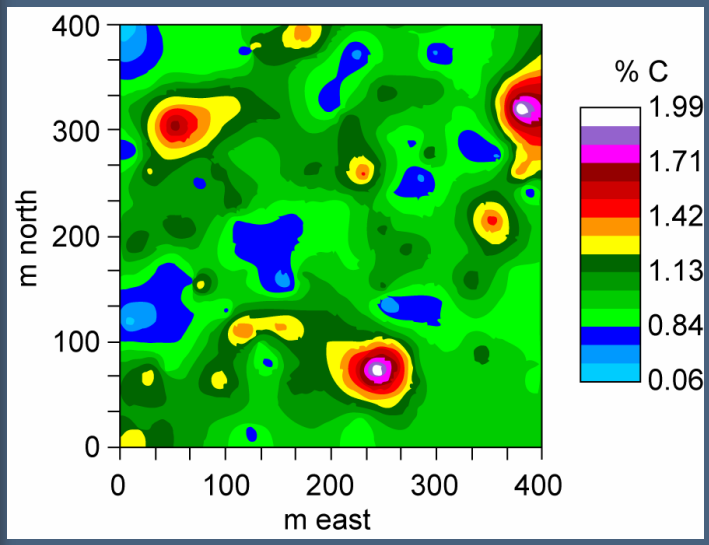
- Soil C stocks and changes in stocks are contingent on several variables
- Non-point sources/sinks



What are the challenges ?

- Soil C stocks and changes in stocks are contingent on several variables
- Non-point sources/sinks
- High spatial and temporal variability.

Spatial variability of surface soil C

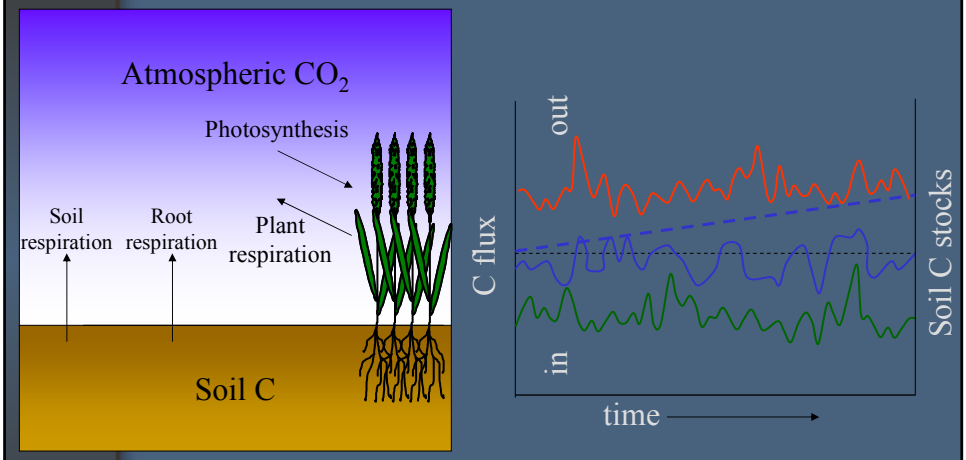


KBS-LTER; CAST 2005

What are the challenges ?

- Soil C stocks and changes in stocks are contingent on several variables
- Non-point sources/sinks
- High spatial and temporal variability.
- Direct measurement of fluxes requires sophisticated technologies.

Carbon changes through fluxes



Changes in soil C stocks are equivalent to the cumulative sum of changes in C fluxes

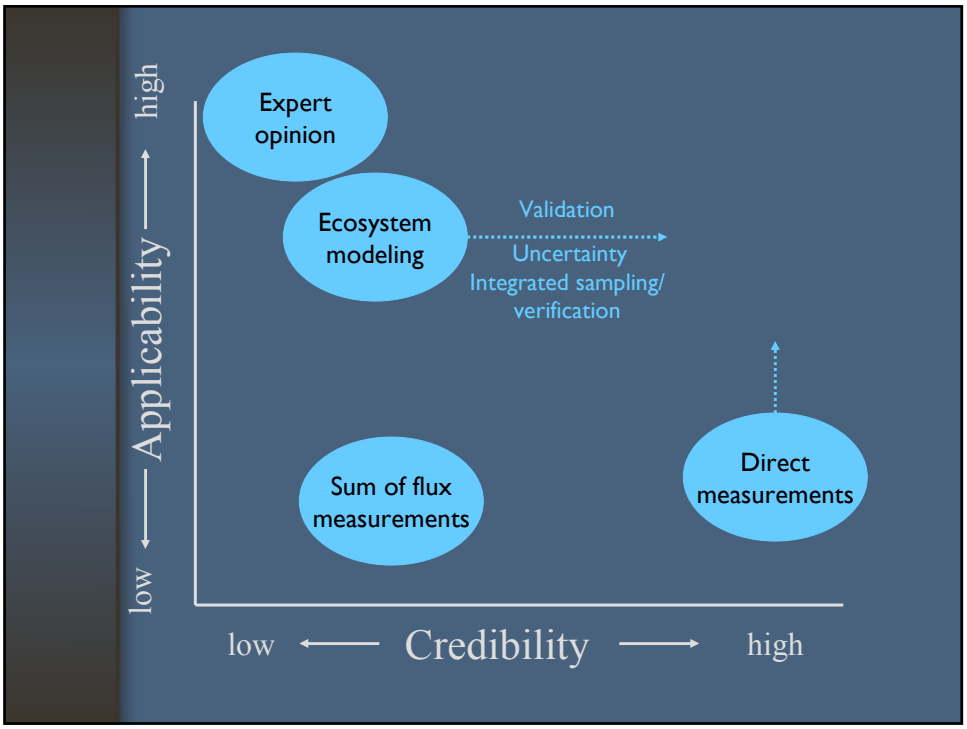
(Δ soil C = Σ Δ soil respiration + Δ photosynthesis + Δ plant respiration + …)

Carbon changes through fluxes

Automated soil flux chamber

Eddy-covariance tower

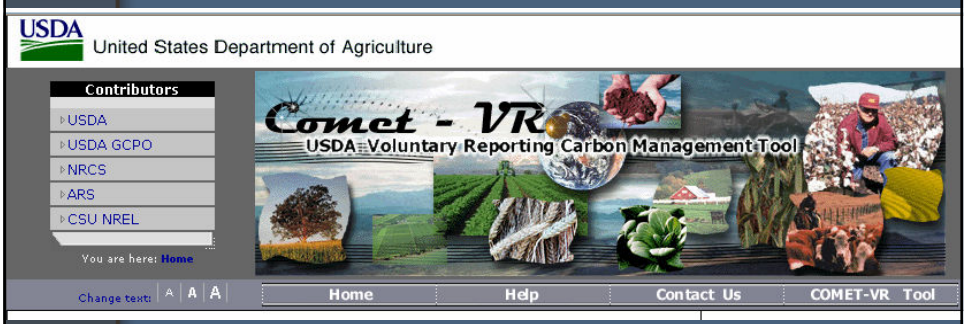
CAST 2005



Requirements for model-based decision support systems (DSS)

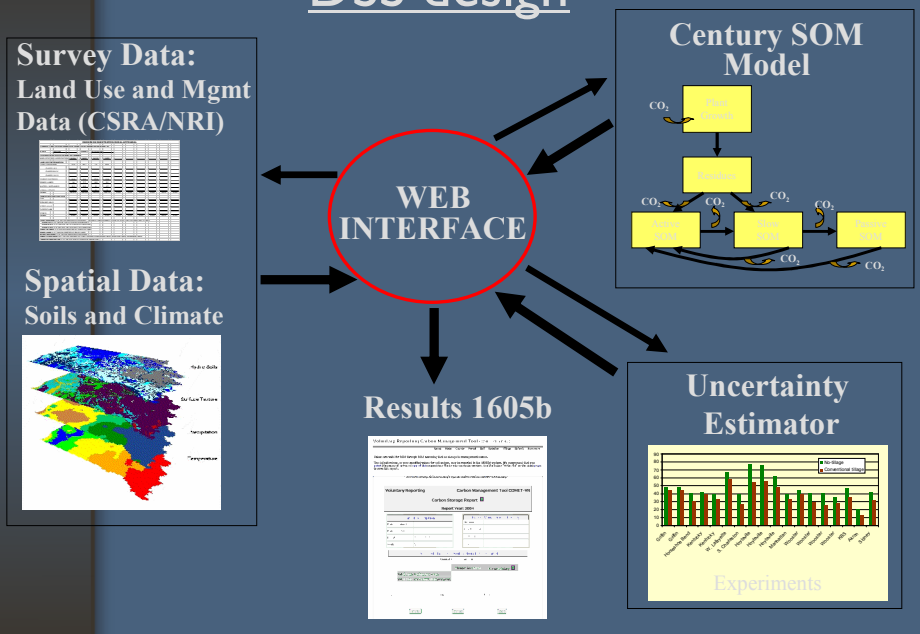
- Effective integration of existing knowledge and data.
- Robust causal relationships that produce *unbiased* estimates.
- Uncertainty is quantified.
- Supported by measurement and monitoring system to enable improvements over time
- General applicability and user-friendliness.

COMET-VR (CarbOn Management and Evaluation Tool – Voluntary Reporting)



- Currently supports soil C estimates and fuel usage estimates
- N_2O emissions will be incorporated in soon

DSS design



COMET-VR History

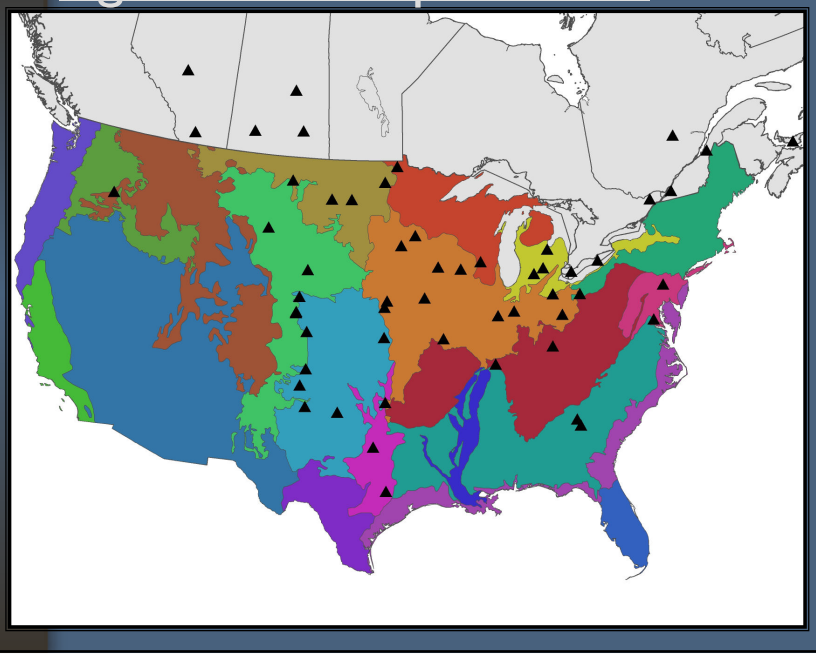
- 1980's – Century model researched and developed
- 1995-2002 – State level and CRP soil carbon assessments (IA, IN, NE)
- 2002 – COMET-VR development began
- 2003-2004 – CSRA data gathering conducted
- 2005 – COMET-VR made web available
- 2006 – COMET-VR used in CSP

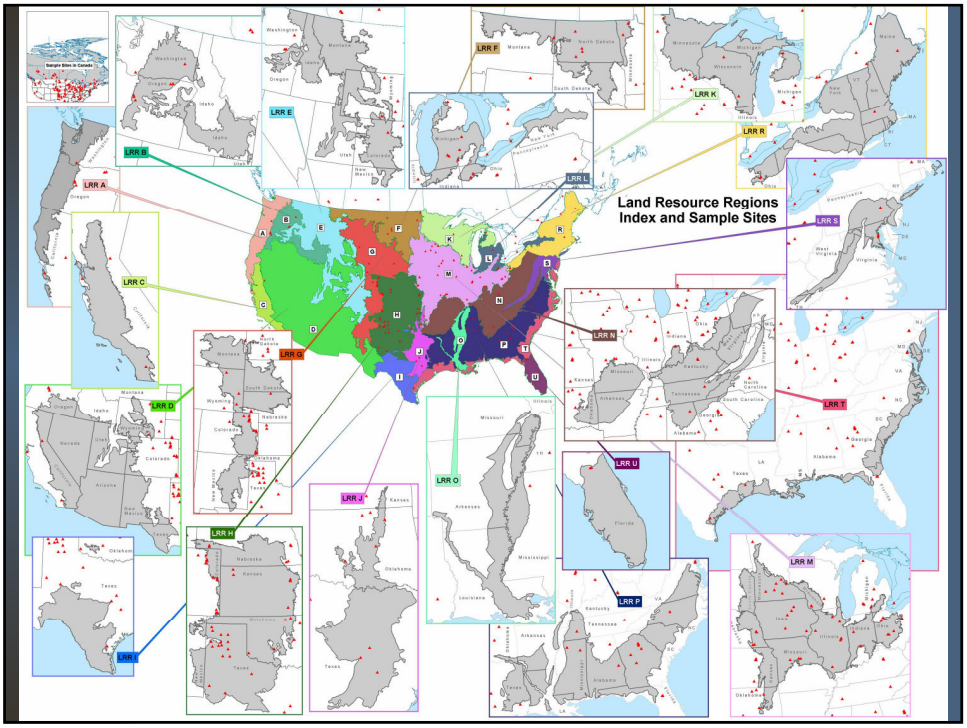
COMET-VR

- **Beta Version**
- 20 LRR's
- < 10 rotation choices per LRR
- 6 soil textures
- Century model w/ uncertainty estimate

- **Version 1.1**
- 226 MLRA's
- 20-40 rotation choices per MLRA
- 12 soil textures
- Century model w/ improved uncertainty estimate

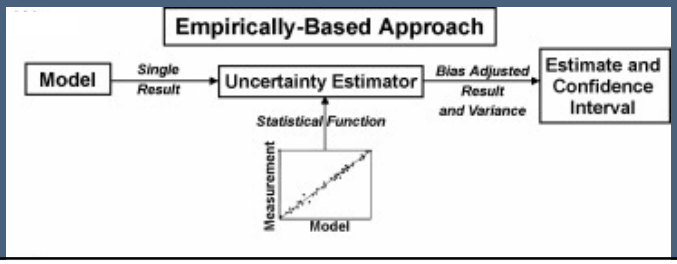
Agricultural Experiments





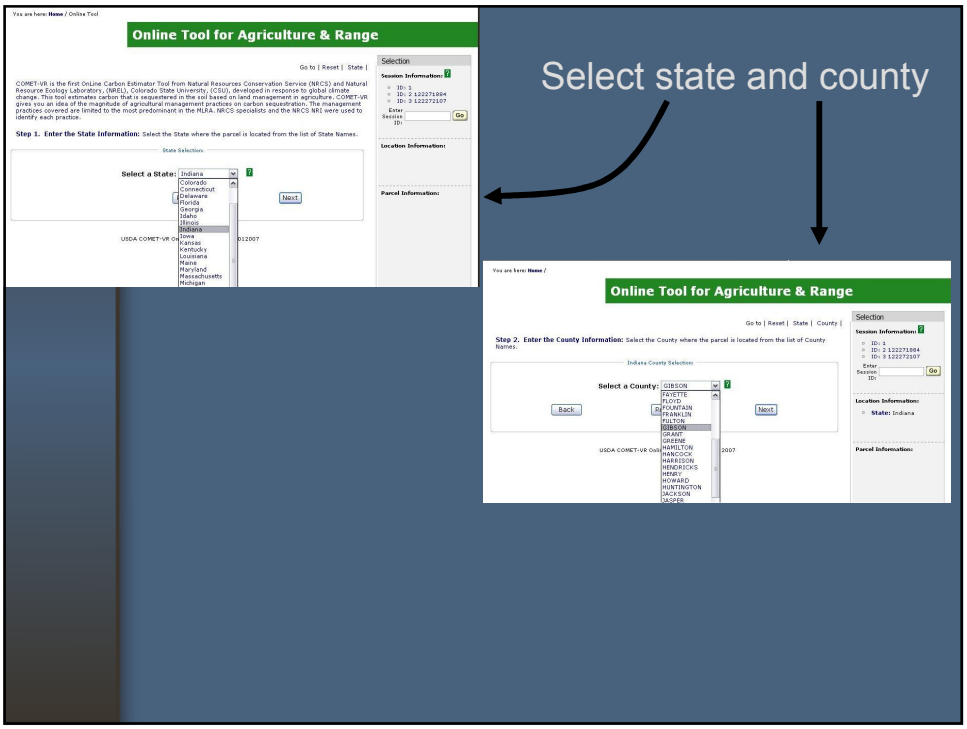
Model Structural Uncertainty

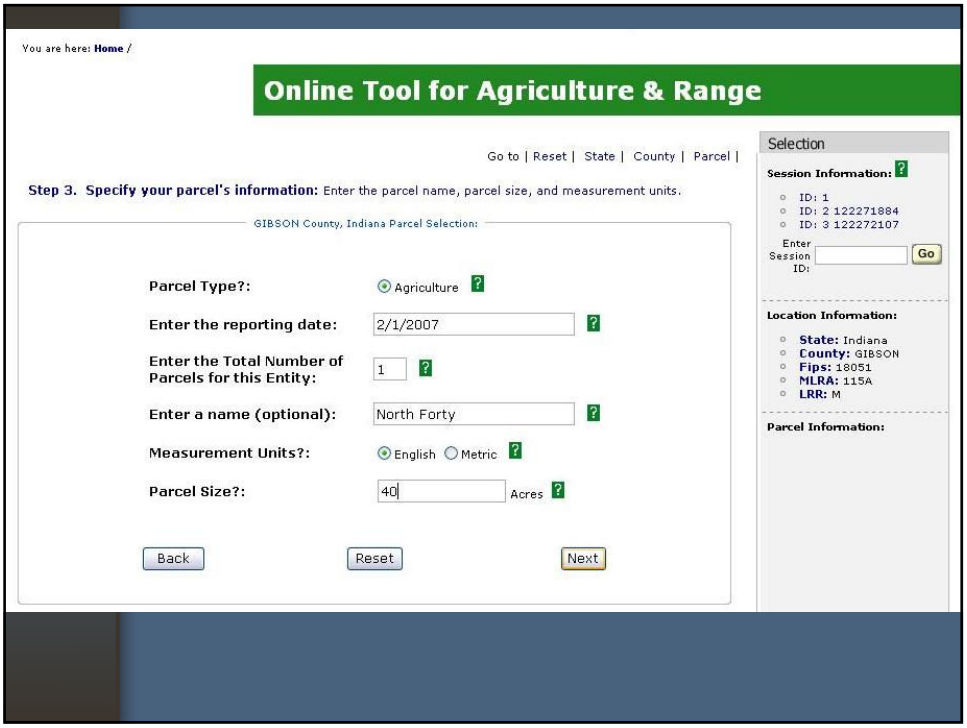
- Uncertainty in model algorithms, parameterization and measurement error
- Empirically-Based approach
  - Uses data 50 sites with over 800 management treatment observations
- 95% CIs at MRLA level, with current data and model, are typically 30-100% of mean

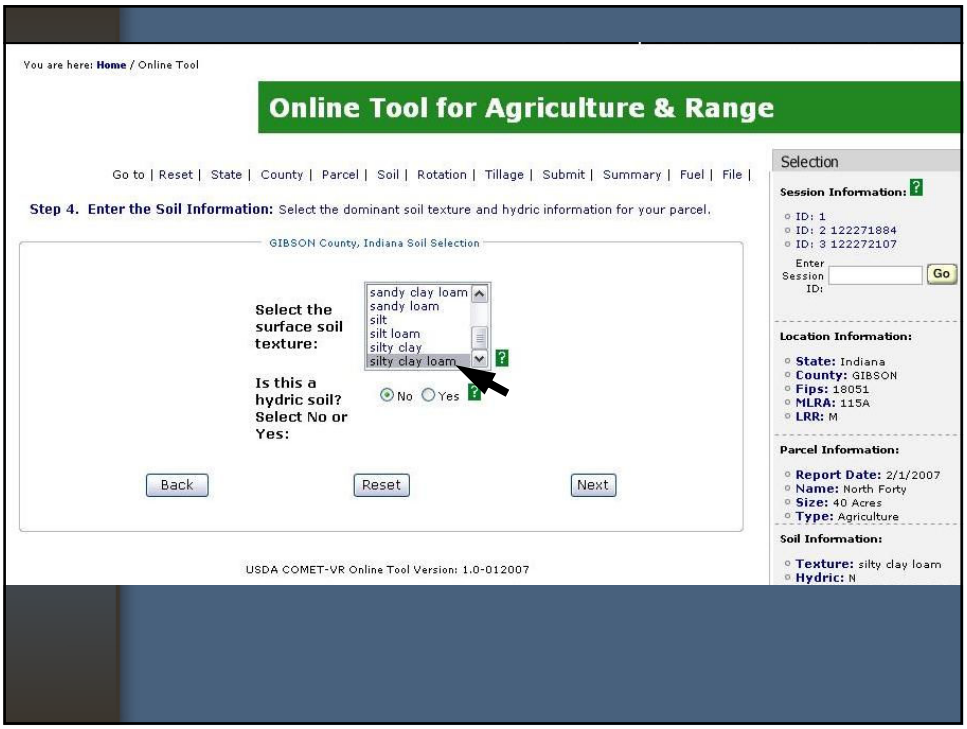


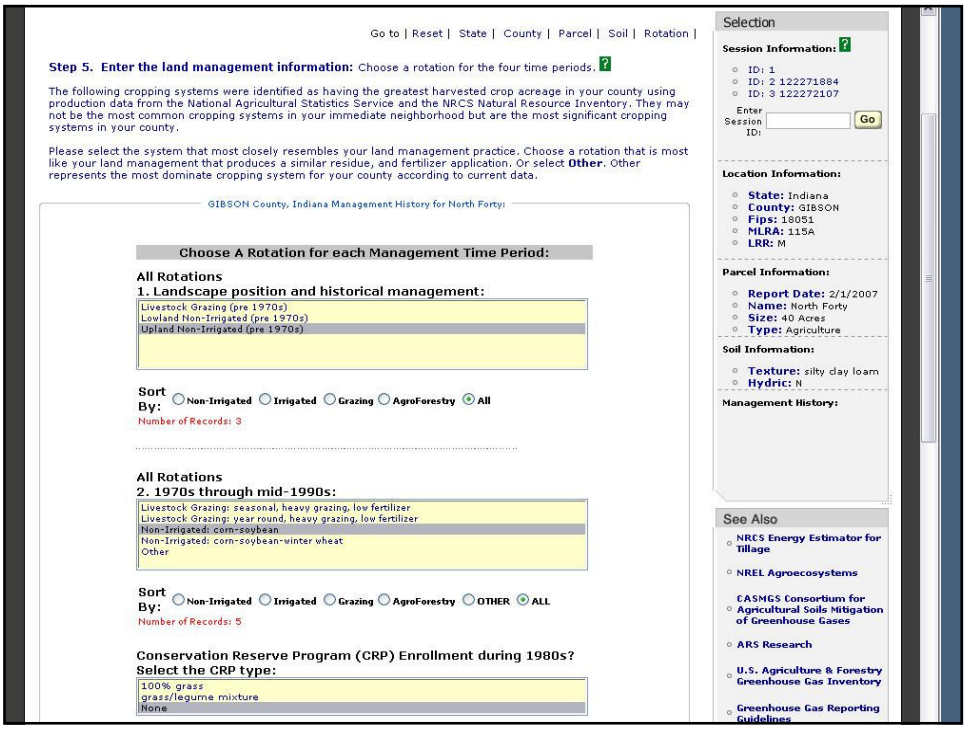
Required Responses to Utilize COMET-VR

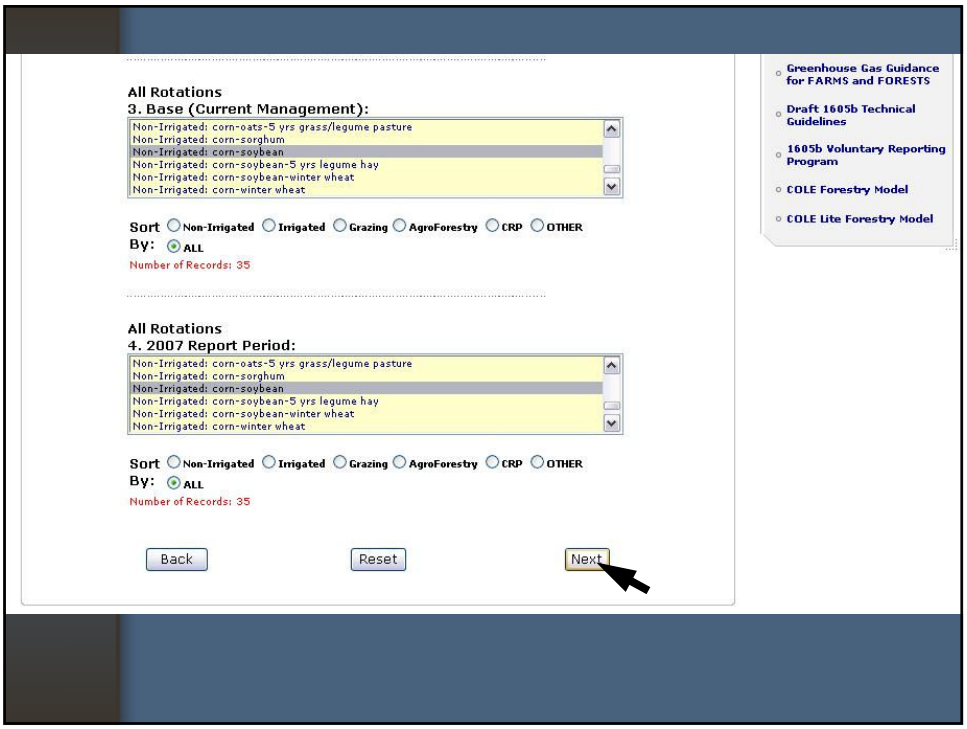
- Location
  - State and County
- Parcel Information
- Soils Information
  - Soil Texture/Hydric Condition
- Management History (crop rotations, tillage systems or grazing systems)
  - Pre 1970's
  - 1970's-1990's
  - Base: 1990's-Current
  - Reporting Period: Current + 10 years

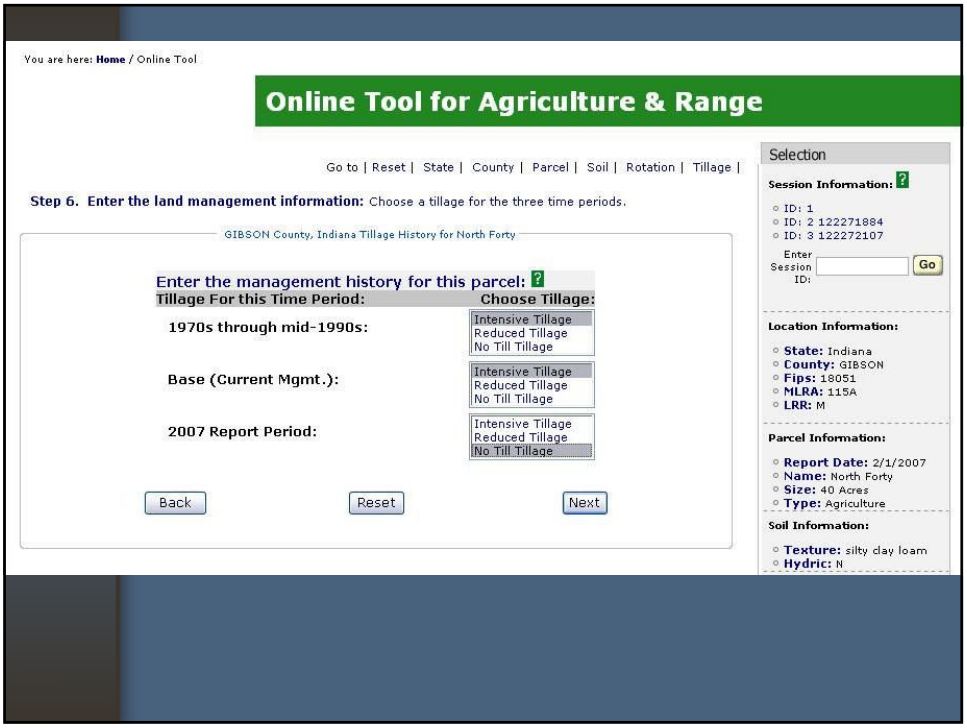

Online Tool for Agriculture & Range
Select state and county
Online Tool for Agriculture & Range

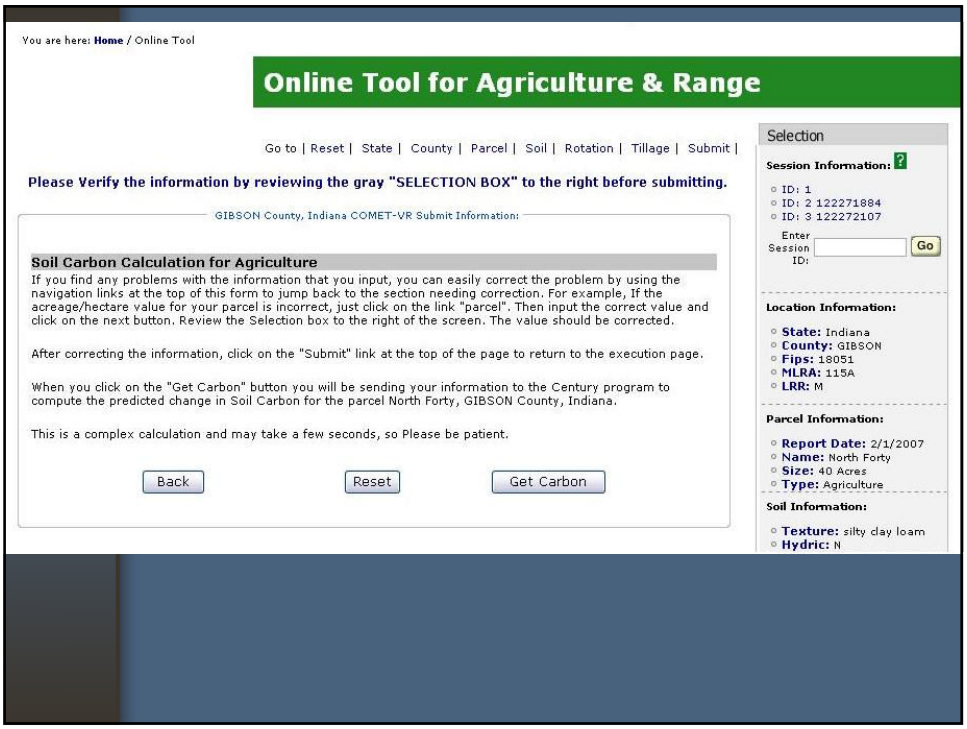

You are here: Home /
Online Tool for Agriculture & Range
Go to | Reset | State | County | Parcel |
Step 3. Specify your parcel's information: Enter the parcel name, parcel size, and measurement units.
GIBSON County, Indiana Parcel Selection:
Parcel Type?: Agriculture
Enter the reporting date: 2/1/2007
Enter the Total Number of Parcels for this Entity: 1
Enter a name (optional): North Forty
Measurement Units?: English Metric
Parcel Size?: 40 Acres
Back
Reset
Next
Selection
Session Information:
ID: 1
ID: 2 122271884
ID: 3 122272107
Enter Session ID:
Go
Location Information:
State: Indiana
County: GIBSON
Fips: 18051
MLRA: 115A
LRR: M
Parcel Information:


You are here: Home / Online Tool
Online Tool for Agriculture & Range
Go to | Reset | State | County | Parcel | Soil | Rotation | Tillage | Submit | Summary | Fuel | File |
Step 4. Enter the Soil Information: Select the dominant soil texture and hydric information for your parcel.
GIBSON County, Indiana Soil Selection
Select the surface soil texture:
sandy clay loam
sandy loam
silt
silt loam
silty clay
silty clay loam
Is this a hydric soil? Select No or Yes:
No Yes
Back
Reset
Next
USDA COMET-VR Online Tool Version: 1.0-012007
Selection
Session Information:
ID: 1
ID: 2 122271884
ID: 3 122272107
Enter Session ID:
Go
Location Information:
State: Indiana
County: GIBSON
Fips: 18051
MLRA: 115A
LRR: M
Parcel Information:
Report Date: 2/1/2007
Name: North Forty
Size: 40 Acres
Type: Agriculture
Soil Information:
Texture: silty clay loam
Hydric: N


Go to | Reset | State | County | Parcel | Soil | Rotation |
Step 5. Enter the land management information: Choose a rotation for the four time periods.
The following cropping systems were identified as having the greatest harvested crop acreage in your county using production data from the National Agricultural Statistics Service and the NRCS Natural Resource Inventory. They may not be the most common cropping systems in your immediate neighborhood but are the most significant cropping systems in your county.
Please select the system that most closely resembles your land management practice. Choose a rotation that is most like your land management that produces a similar residue, and fertilizer application. Or select Other. Other represents the most dominate cropping system for your county according to current data.
GIBSON County, Indiana Management History for North Forty:
Choose A Rotation for each Management Time Period:
All Rotations
1. Landscape position and historical management:
Livestock Grazing (pre 1970s)
Lowland Non-Irrigated (pre 1970s)
Upland Non-Irrigated (pre 1970s)
Sort By: Non-Irrigated Irrigated Grazing AgroForestry All
Number of Records: 3
All Rotations
2. 1970s through mid-1990s:
Livestock Grazing: seasonal, heavy grazing, low fertilizer
Livestock Grazing: year round, heavy grazing, low fertilizer
Non-Irrigated: corn-soybean
Non-Irrigated: corn-soybean-winter wheat
Other
Sort By: Non-Irrigated Irrigated Grazing AgroForestry OTHER ALL
Number of Records: 5
Conservation Reserve Program (CRP) Enrollment during 1980s?
Select the CRP type:
100% grass
grass/legume mixture
None
Selection
Session Information:
ID: 1
ID: 2 122271884
ID: 3 122272107
Enter Session ID:
Go
Location Information:
State: Indiana
County: GIBSON
Fips: 18051
MLRA: 115A
LRR: M
Parcel Information:
Report Date: 2/1/2007
Name: North Forty
Size: 40 Acres
Type: Agriculture
Soil Information:
Texture: silty clay loam
Hydric: N
Management History:
See Also
NRCS Energy Estimator for Tillage
NREL Agroecosystems
CASMGS Consortium for Agricultural Soils Mitigation of Greenhouse Gases
ARS Research
U.S. Agriculture & Forestry Greenhouse Gas Inventory
Greenhouse Gas Reporting Guidelines


All Rotations
3. Base (Current Management):
Non-Irrigated: corn-oats-5 yrs grass/legume pasture
Non-Irrigated: corn-sorghum
Non-Irrigated: corn-soybean
Non-Irrigated: corn-soybean-5 yrs legume hay
Non-Irrigated: corn-soybean-winter wheat
Non-Irrigated: corn-winter wheat
Sort By: Non-Irrigated Irrigated Grazing AgroForestry CRP OTHER ALL
Number of Records: 35
All Rotations
4. 2007 Report Period:
Non-Irrigated: corn-oats-5 yrs grass/legume pasture
Non-Irrigated: corn-sorghum
Non-Irrigated: corn-soybean
Non-Irrigated: corn-soybean-5 yrs legume hay
Non-Irrigated: corn-soybean-winter wheat
Non-Irrigated: corn-winter wheat
Sort By: Non-Irrigated Irrigated Grazing AgroForestry CRP OTHER ALL
Number of Records: 35
Back
Reset
Next
Greenhouse Gas Guidance for FARMS and FORESTS
Draft 1605b Technical Guidelines
1605b Voluntary Reporting Program
COLE Forestry Model
COLE Lite Forestry Model


You are here: Home / Online Tool
Online Tool for Agriculture & Range
Go to | Reset | State | County | Parcel | Soil | Rotation | Tillage |
Step 6. Enter the land management information: Choose a tillage for the three time periods.
GIBSON County, Indiana Tillage History for North Forty
Enter the management history for this parcel:
Tillage For this Time Period:
Choose Tillage:
1970s through mid-1990s:
Intensive Tillage
Reduced Tillage
No Till Tillage
Base (Current Mgmt.):
Intensive Tillage
Reduced Tillage
No Till Tillage
2007 Report Period:
Intensive Tillage
Reduced Tillage
No Till Tillage
Back
Reset
Next
Selection
Session Information:
ID: 1
ID: 2 122271884
ID: 3 122272107
Enter Session ID:
Go
Location Information:
State: Indiana
County: GIBSON
Fips: 18051
MLRA: 115A
LRR: M
Parcel Information:
Report Date: 2/1/2007
Name: North Forty
Size: 40 Acres
Type: Agriculture
Soil Information:
Texture: silty clay loam
Hydric: N


You are here: Home / Online Tool
Online Tool for Agriculture & Range
Go to | Reset | State | County | Parcel | Soil | Rotation | Tillage | Submit |
Please Verify the information by reviewing the gray "SELECTION BOX" to the right before submitting.
GIBSON County, Indiana COMET-VR Submit Information:
Soil Carbon Calculation for Agriculture
If you find any problems with the information that you input, you can easily correct the problem by using the navigation links at the top of this form to jump back to the section needing correction. For example, If the acreage/hectare value for your parcel is incorrect, just click on the link "parcel". Then input the correct value and click on the next button. Review the Selection box to the right of the screen. The value should be corrected.
After correcting the information, click on the "Submit" link at the top of the page to return to the execution page.
When you click on the "Get Carbon" button you will be sending your information to the Century program to compute the predicted change in Soil Carbon for the parcel North Forty, GIBSON County, Indiana.
This is a complex calculation and may take a few seconds, so Please be patient.
Back
Reset
Get Carbon
Selection
Session Information:
ID: 1
ID: 2 122271884
ID: 3 122272107
Enter Session ID:
Go
Location Information:
State: Indiana
County: GIBSON
Fips: 18051
MLRA: 115A
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Parcel Information:
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Name: North Forty
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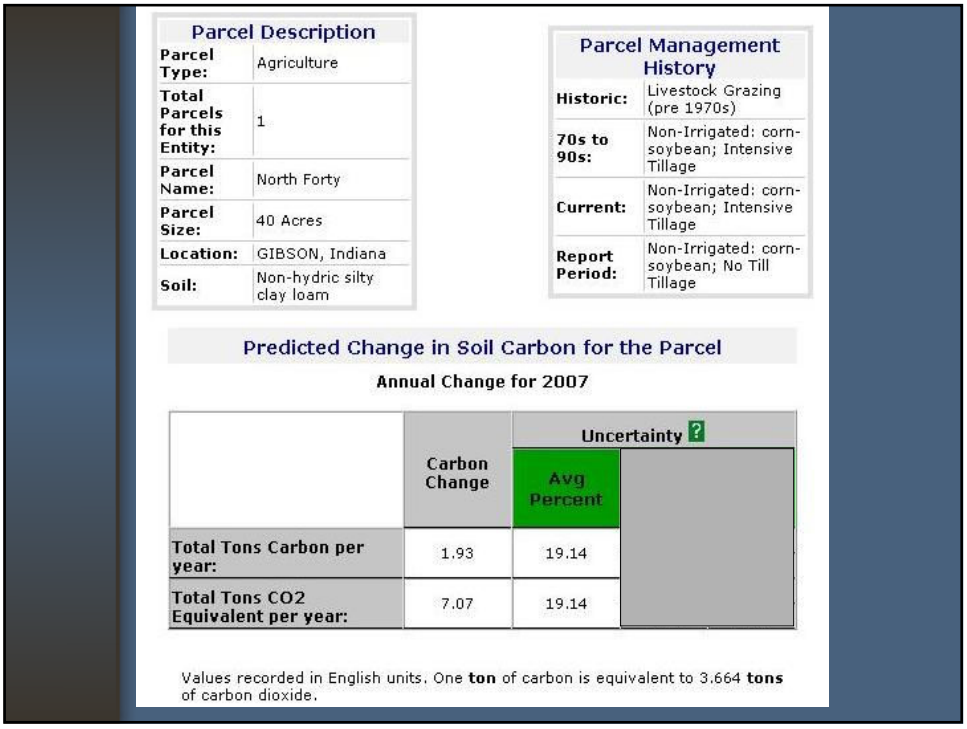
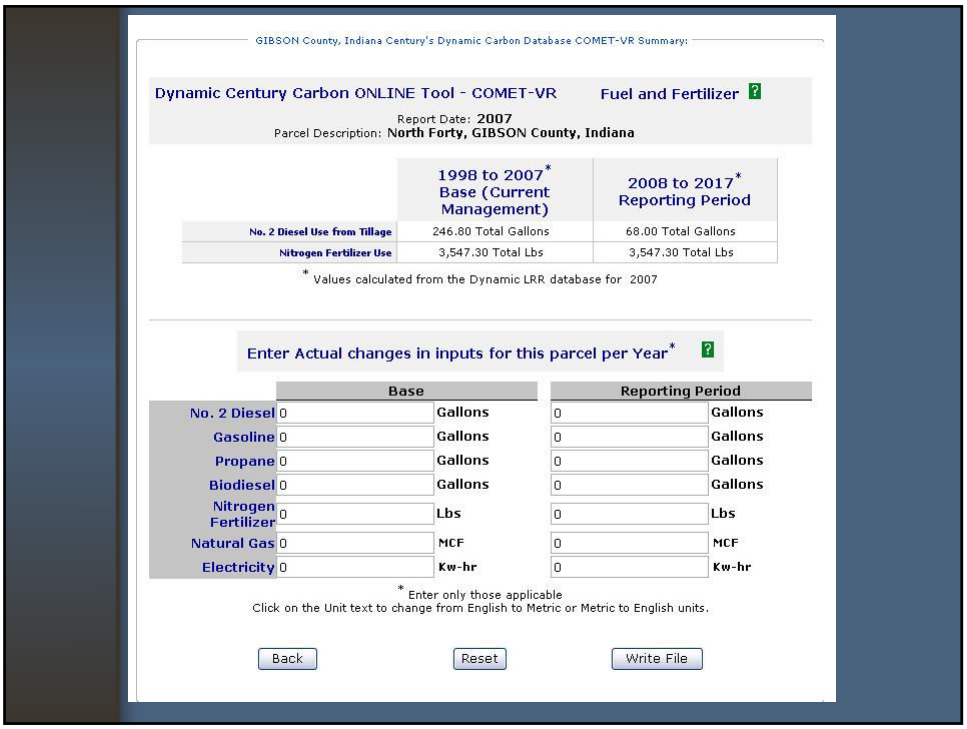
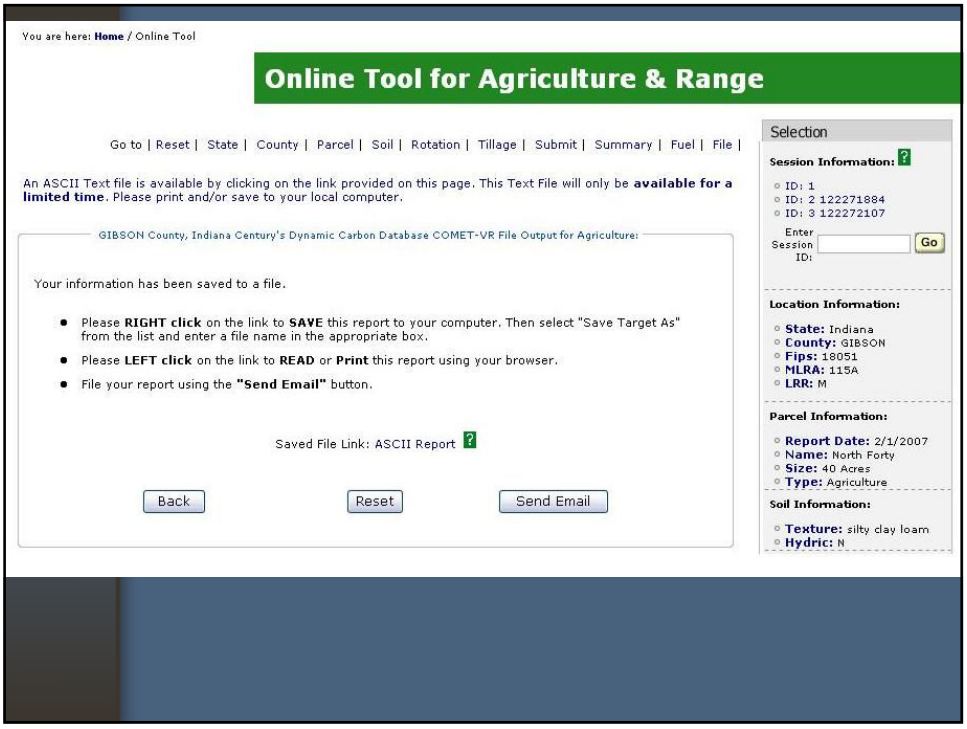

Parcel Description
Parcel Type: Agriculture
Total Parcels for this Entity: 1
Parcel Name: North Forty
Parcel Size: 40 Acres
Location: GIBSON, Indiana
Soil: Non-hydric silty clay loam
Parcel Management History
Historic: Livestock Grazing (pre 1970s)
70s to 90s: Non-Irrigated: corn-soybean; Intensive Tillage
Current: Non-Irrigated: corn-soybean; Intensive Tillage
Report Period: Non-Irrigated: corn-soybean; No Till Tillage
Predicted Change in Soil Carbon for the Parcel
Annual Change for 2007
Carbon Change
Uncertainty
Avg Percent
Total Tons Carbon per year: 1.93 19.14
Total Tons CO2 Equivalent per year: 7.07 19.14
Values recorded in English units. One ton of carbon is equivalent to 3.664 tons of carbon dioxide.


GIBSON County, Indiana Century's Dynamic Carbon Database COMET-VR Summary:
Dynamic Century Carbon ONLINE Tool - COMET-VR
Fuel and Fertilizer
Report Date: 2007
Parcel Description: North Forty, GIBSON County, Indiana
1998 to 2007* Base (Current Management)
2008 to 2017* Reporting Period
No. 2 Diesel Use from Tillage
246.80 Total Gallons
68.00 Total Gallons
Nitrogen Fertilizer Use
3,547.30 Total Lbs
3,547.30 Total Lbs
* Values calculated from the Dynamic LRR database for 2007
Enter Actual changes in inputs for this parcel per Year*
Base
Reporting Period
No. 2 Diesel 0 Gallons 0 Gallons
Gasoline 0 Gallons 0 Gallons
Propane 0 Gallons 0 Gallons
Biodiesel 0 Gallons 0 Gallons
Nitrogen Fertilizer 0 Lbs 0 Lbs
Natural Gas 0 MCF 0 MCF
Electricity 0 Kw-hr 0 Kw-hr
* Enter only those applicable
Click on the Unit text to change from English to Metric or Metric to English units.
Back
Reset
Write File


You are here: Home / Online Tool
Online Tool for Agriculture & Range
Go to | Reset | State | County | Parcel | Soil | Rotation | Tillage | Submit | Summary | Fuel | File |
An ASCII Text file is available by clicking on the link provided on this page. This Text File will only be available for a limited time. Please print and/or save to your local computer.
GIBSON County, Indiana Century's Dynamic Carbon Database COMET-VR File Output for Agriculture:
Your information has been saved to a file.
Please RIGHT click on the link to SAVE this report to your computer. Then select "Save Target As" from the list and enter a file name in the appropriate box.
Please LEFT click on the link to READ or Print this report using your browser.
File your report using the "Send Email" button.
Saved File Link: ASCII Report
Back
Reset
Send Email
Selection
Session Information:
ID: 1
ID: 2 122271884
ID: 3 122272107
Enter Session ID:
Go
Location Information:
State: Indiana
County: GIBSON
Fips: 18051
MLRA: 115A
LRR: M
Parcel Information:
Report Date: 2/1/2007
Name: North Forty
Size: 40 Acres
Type: Agriculture
Soil Information:
Texture: silty clay loam
Hydric: N

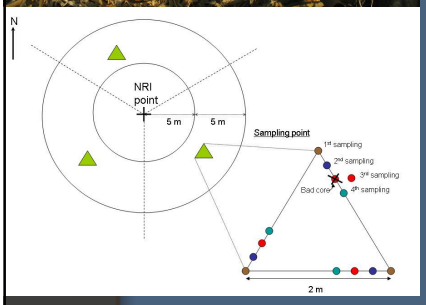
- 2006 CSP - EAM-40 (COMET-VR)
- 18 states
- $450,000
- 900 contract-years

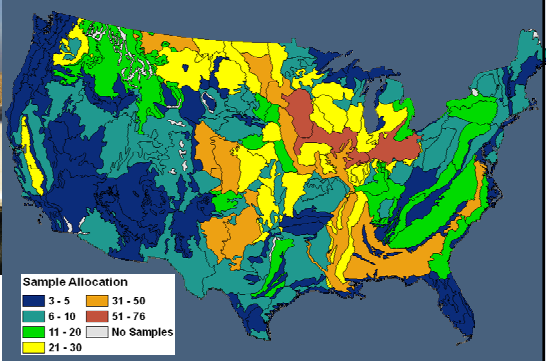
COMET-VR applications

- 1605B voluntary reporting of GHGs
  - Initiated in 1992 Energy Policy Act
  - Administered by DOE
  - Revised guidelines issued in Jan 2007
- USDA Farm programs
  - C sequestration included as part of the Conservation Security Program
  - Future farm bill legislation ?
- C trading?? – YES in state of CO

COMET-VR Enhancements

- Improved feedback and user response
- Continue soil carbon reporting in CSP
- Tool evaluations/questionnaires
- Improved uncertainty estimation

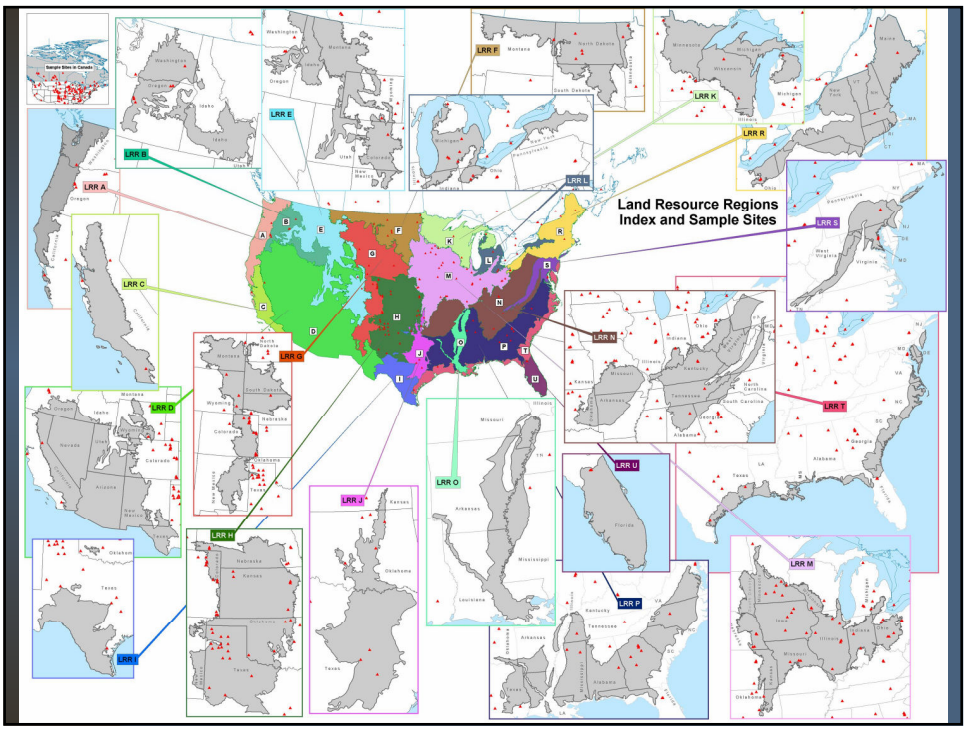




Developing a national measurement network to refine uncertainty analysis (3000-5000 sites)

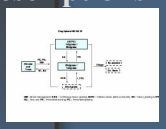
COMET-VR Enhancements II

- NRCS is currently looking at the addition of new management systems for COMET-VR.
- A link to COLE – the forest land C sequestration estimator.
- COMET-VR for agroforestry, fruit and nut orchards is being implemented.
- COMET-VR expansion to Hawaii
- Expansion of rangeland and rangeland management options

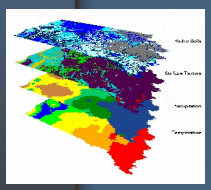


Rangeland DSS

Ecological site descriptions

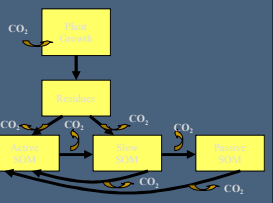


Spatial Data:
Soils and Climate



WEB INTERFACE

Century SOM Model

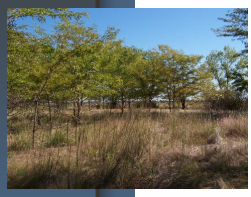


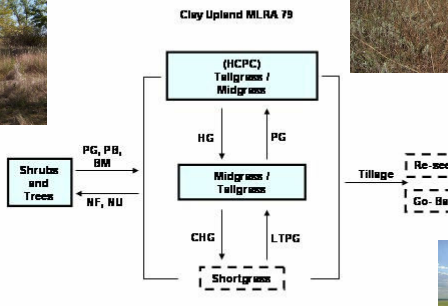
Results 1605b

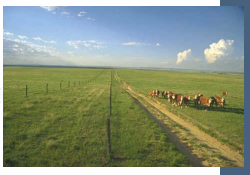
Uncertainty Estimator

???

Ecological site descriptions







For more information:

- http://www.airquality.nrcs.usda.gov
- http://www.cometvr.colostate.edu